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Dyeing of Cotton Fabric with Natural Dye obtained from Flower of *Thespesia Populnea* using Combination of Mordants

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Abstract

The fastness properties of the flower of Thespesia populnea dyed cotton fabric have been studied using different combination (1:3,1:1 and 3:1) of various mordants, such as myrobolan:nickel sulphate, myrobolan: aluminium sulphate, myrobolan: potassium dichromate, myrobolan: ferrous sulphate and myrobolan:stannous chloride. The wash, rub, light and perspiration fastness of the dyed samples have been evaluated. Comparing thefastness properties and colour strength of flower of Thespesia populnea dyed cotton by using combination of mordants. In the comparative study of fastness properties and colour strength of the dyed cotton samples Thespesia populnea in simultaneous mordanting method with 1 : 3 mordant combination gives better results.

Keywords: *Cotton; Dyeing; Mordant; Natural dye; Thespesia populnea.*

1. INTRODUCTION

In olden days, People are using natural dyes for colouring and also those natural dyes used to be the main colourants for textiles. But the introduction of synthetic dyes led to an almost complete replacement of natural dyes, due to favorable application properties of synthetic dyes. Besides, a wide range of available colours, higher reproducibility and improved quality of dyeing could be achieved at lower specific cost. However, recently the interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries in response to toxic and allergic reactions associated with synthetic dyes (Anderson, 1971; Samanta *et al.* 2007; Sabdeep Bains *et al.* 2005). Hence, due to the current eco-consciousness, the researcher's attention has been shifted to the use of natural dyes for dyeing textile materials (Sandeep Bains *et al.* 2003; Gulrajani and Gupta Deepti, 1992; Thomas Bechtold *et al.* 2006).

2. MATERIALS & METHODS

The present investigation deals with the extraction of natural dye from the flower of *Thespesia populnea*. The present investigation deals with the extraction of natural dye from the flower of *Thespesia populnea*. Milo (*Thespesia populnea*) is one of the most important trees to Pacific Island peoples. The rich, dark wood is carved into beautiful bowls, tools, small canoes, and figures. Ropes are twisted from the bark. The trees provide protection against wind, salt spray, and the hot sun. The seeds, leaves, and bark provide medicine and food.

Fig. 1: Flower of *Thespesia populnea*

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In ancient times the trees were planted around temple sites. Today the tree is rarer than in the past because of overharvesting in some areas and increased urbanization in others. The tree is easy to grow and should be considered for reforestation and urban forestry projects in the Pacific where suitable sites are available.

Milo (Kumaresan *et al.* 2017a; 2017b) is a small evergreen tree averaging 6–10 m (20–33 ft) in height, with a short, often crooked stem and a broad, dense crown. It has glossy green, heart-shaped leaves and yellow hibiscus-type flowers. The tree grows well along warm coastal areas from the east coast of Africa and South and Southeast Asia to Melanesia, Micronesia, and Polynesia. It is currently naturalized in tropical climates throughout the world from the Caribbean to Africa.

The tree is valuable as a coastal windbreak because it is highly resistant to wind and salt spray and grows well in sandy, saline soils. It propagates easily and grows rapidly. It naturalizes easily and has become a weed in some areas, so it should not be planted in areas where it is not already present. The tree grows best under full sunlight and tolerates drought conditions. The heartwood is resistant to dry wood termites. Milo has many uses including coastal protection, animal fodder, windbreaks, and living fences. The most common use in the Pacific today is probably as an ornamental tree, despite its valuable timber.

Bleached cotton fabric obtained from Gandhigram Rural University, Dindugal**,** was used for the study. Analytical reagents (AR) grade ferrous sulphate, aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, commercial grade acetic acid, common salt, sodium carbonate were used. A natural mordant myrobolan (*Terminalia chebula*) powder (Kumar *et al.* 2004; Kumaresan *et al.* 2010) was used for the study. The ethanol extract of the flower of *Thespesia populnea* was used to get brown colour component for dyeing of fabrics. Depending upon the mordant used, the colour obtained on textiles from the flower of *Thespesia populnea* extract may give different shades.

A known quantity of flower of *Thespesia populnea* was dried, powdered and soaked in warm water overnight. The colour extract was obtained by boiling it in the same water. This dye extract was allowed to cool, finally filtered and used for dyeing. The dyeing was carried out at optimized dyeing conditions: dye extraction time 60 min, material-to-liquor ratio 1:20, temp. 60 ˚C, wave length 420 nm and dyeing time 50 min. The mordant combinations, viz. myrobolan: nickel sulphate, myrobolan: aluminium sulphate, myrobolan: potassium dichromate, myrobolan: ferrous sulphate, myrobolan: stannous chloride were used each in the ratio of 1:3, 1:1 and 3:1. The total amount of two mordants used in each combination was 5% owf, i.e. 5 g of the mordant / 100 g of the fabric. Each of the five mordant combinations in three different ratios mentioned above was used with all the three mordanting methods, namely pre-mordanting, simultaneous mordanting and post-mordanting for dyeing (Kumaresan *et al.* 2011a; 2011b).

Colour fastness to washing (Kumaresan *et al.* 2012a; 2012b) of the dyed fabric samples was determined as per IS: 764 – 1984 method using a Sasmira launder-O-meter following IS-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (extent of staining) and the same was cross-checked by measuring the loss of depth of colour and staining using Macbeth 2020 plus computer-aided colour measurement system attached with relevant software. Colour fastness to rubbing (dry and wet) was assessed as per IS: 766-1984 method using a manually operated crock meter and grey scale as per ISO-105-AO3 (extent of staining).

Colour fastness to exposure to light was determined as per IS: 2454-1984 method. The sample was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (having 500 watt Philips mercury bulb tungsten filament lamp simulating day light) along with the eight blue wool standards (BS1006: BOI: 1978). The fading of each sample was observed against the fading of blue wool standards (1-8).

Colour fastness to perspiration (Kumaresan *et al.* 2012c; Kumaresan, 2014; 2015) was assessed according to IS 971-1983, composite specimen was prepared by placing the test specimen between two adjacent pieces of cotton and stitched all among four sides. The sample was soaked in the test solution (acidic /alkaline) separately with MLR 1:50 for 30 min at room temperature. The sample was then placed between two glass plates of perspirometer under load of 4.5kg (10 lbs). The apparatus was kept in the oven for 4 h at 37±2˚C. At the end of this period, the specimen was removed and dried in air at a temperature not exceeding 60 ˚C. The test samples were graded for change in colour and staining using grey scales.

The evaluation of colour fastness to light, washing, rubbing and perspiration using myrobolan: nickel sulphate combination in aqueous medium is

presented in Table 1. All the treated samples subjected to light show fairly good (3-4) light fastness for all mordant combinations. The wash fastness grades range between 3 and 4 for all of the treated samples and there is no colour staining observed.

The colour change to dry and wet rubbing for all the treated samples is found to be excellent (5). There is a variation from no colour staining to negligible colour staining (5 to 4-5) in dry rubbing. Most of the treated samples show excellent fastness grade to colour change in both acidic and alkaline media. There is no colour staining (5) observed for all the treated samples in both acidic and alkaline media (Table 1).

For the present study, three different combinations of mordants such as 1 : 3, 1 : 1 and 3 : 1 were prepared by mixing the natural mordant myrobolan with five inorganic mordants and dyed on silk fabrics. The colour fastness and colour strength values of dyed silk fabrics by using various combinations of mordants obtained in the present study and the values obtained by the earlier researchers are presented in Table 1.1. In all the three methods of dyeing using three plant parts, the mordants ferrous sulphate and aluminium sulphate showed excellent results.

Table 1. Comparison of fastness properties and colour strength of dyed cotton in combination of mordants

Plant parts used for dyeing	Mordant used	Method	Properties							Reference
			WF	LF	RF		PF		CS (K/S)	
					Dry	Wet	Acidic	Alkaline		
Flower of *Thespesia populnea*	MB : AS (1 : 3)	SM	5	4	5	5	4	4-5	3.41	Present Study
		PM	5	3-4	5	5	5	5	3.01	
	MS :FS (1 : 3)	SM	5	3-4	5	5	5	5	3.52	
		PM	5	3-4	5	5	4	5	3.03	
Flower of *Spathodea campanulata*	MB : AS (1 : 3)	SM	5	4	5	4	4	4-5	3.41	Kumaresan (2015)
		PM	5	3-4	5	4	5	5	3.01	
	MS :FS (1 : 3)	SM	5	3-4	5	5	5	5	3.52	
		PM	4	3-4	5	5	4	5	3.03	
Flower of *Cordia sebestena*	MB : AS (1 : 3)	SM	4	3-4	5	5	4	4-5	3.18	Kumaresan *et al.* (2016)
		PM	5	3-4	4-5	5	5	5	2.91	
	MS :FS (1 : 3)	SM	5	3-4	4-5	5	4	5	3.26	
		PM	5	3-4	5	5	5	5	2.89	
Prunus persica	AS : $CuSO_4$ (1 : 3)	SM	4-5	4-6	4-5	4-5	5	5	-	Surabhi mahajan *et al.* (2005)
	AS : FS (1 : 3)	SM	5	5-6	4-5	4-5	4-5	4-5	-	
	$CuSO_4$: FS (1 : 3)	SM	5	5-6	4-5	4-5	4-5	4-5	-	
Jackfruit wood (Jute)	MB : SC (20 : 20)	PM	5	1	4-5	4-5	-	-	3.13	Samanta *et al.* (2007)
	MB : AS (20 : 20)	PM	4	3	5	5	-	-	3.35	
Jackfruit leaf(Jute)	Potash alum(12%)	PM	-	-	-	-	-	-	4.48	Pan *et al.* (2003)
Marigold flower(Jute)	Potash alum(12%)	PM	-	-	-	-	-	-	5.06	

WF-Wash fastness; LF-Light fastness; PF-Perspiration fastness; RF-Rub fastness; CS-Colour strength; PM-Pre mordanting; SM-Simultaneous mordanting; MB – Myrobolan; FS –Ferrous sulphate; AS- Aluminium sulphate; SC- Stannous chloride; $CuSO_4$-Copper sulphate.

From the comparison of colour strength results, it is clear that among the three mordant combinations 1 : 3 mordant combination is found to be better for dyeing. Comparing the three dyeing methods, simultaneous method in all two natural dyes gave excellent results.

Similar results were obtained in the previous study reported by Surabhi mahajan *et al.* (2005). Analysis of data from the Table 1 indicates that higher the concentration of mordants the higher will be the K/S value (Pan *et al.* 2003).A better light fastness (GS : 4-5) was observed in the present study compared to Kumaresan (2015), study when stannous chloride (GS : 2) was used as a mordant in premordanting method.

In the comparative study of fastness properties and colour strength of the dyed silk samples *Thespesia populnea* in simultaneous mordanting method with 1 : 3 mordant combination gives better results. From this results, the dyeing ability for *Thespesia populnea* is better than the other natural dyes obtained from Flower of *Cordia sebestena and Spathodea campanulata*

REFERENCES

Anderson, B., Creative spinning, weaving and plant dyeing, Angus and Robinson, Singapore, 24-28 (1971).

Gulrajani, M. L. and Gupta Deepti, Natural dyes and their application to textiles, Department of Textile Technology, IIT, Delhi,10-25(1992).

Kumar, P. E., Kumaresan, M. and Boopathi, T. S., A study on the extraction of eco-friendly natural dyes from *Pongamia pinnato* for dyeing, Bharathiar University, Coimbatore(2004).

Kumaresan, M. and Senthilkumar, K., Dyeing of silk with eco-friendly natural dyes obtained from flower of *Plumeria Species* using single mordants, *J. Chem. Pharma. Sci*., 9(1), 313- 317(2016a).

Kumaresan, M., Balasubramaniam, P., Dhanasekaran, E. and Sudha, N., Preparation of Nano Natural Dyes from the Flower of *Russelia Equisetiformis* and Applying on Fabrics Using Mordants, SSRG *Int. J. Appl. Chem*., (SSRG-IJAC), 4(1), 01-03(2017a).

Kumaresan, M., Dyeing of cotton fabric with eco-friendly natural dye obtained from flower of *Thespesia populnea* using single mordants, *Int. J. Mod. Trends Eng. Sci*.**,** 4(12), 01-04(2017b).

Kumaresan, M., Dyeing of cotton with eco-friendly natural dyes obtained from flower of Plumeria species using single mordants, *Int. J. Chem. Tech. Res.*, 8(12), 411-417, (2015).

Kumaresan, M., Dyeing of cotton with eco-friendly natural dyes obtained from the flower of *Russelia equisetiformis* using single mordants, *Int. J. Appl. Res.*, 2(8), 570-580(2016b).

Kumaresan, M., Fastness properties of dyed silk fabric with eco-friendly natural dyes obtained from *Achras sapota and Cordia sebestena*- A Comparison, *J. Environ. Nanotechnol*., 3(2), 194-199(2014).
doi : 10.13074/jent.2014.03.143084

Kumaresan, M., Palanisamy, P. N. and Kumar, P. E., Application of eco-friendly natural dye obtained from *Cordia sebestena* on cotton using combination of mordants, *J. Nat. Prod. Plant. Res.*, 2(1), 32-38(2012a).

Kumaresan, M., Palanisamy, P. N. and Kumar, P. E., Application of eco-friendly natural dye on cotton using combination of mordants, *Ind. J. Fibre. Textile. Res*., 37, 194-198(2012b).

Kumaresan, M., Palanisamy, P. N. and Kumar, P. E., Dyeing of cotton using flower of *Cordia sebestena*: Effects of mordanting and fastness properties, *J. Asian Scient. Res*., 1(4), 137-142(2011a).

Kumaresan, M., Palanisamy, P. N. and Kumar, P. E., Dyeing of cotton and silk fabrics using stem of *Achras sapota* extract: Effects of mordanting and dyeing process variables on colour yield and colour fastness properties, *Asian J. Exp. Chem.*, 6(1), 01-07(2011b).

Kumaresan, M., Palanisamy, P. N. and Kumar, P.,E., Dyeing of silk fabric with eco-friendly natural dyes using single mordants: Comparison of fastness properties and colour strength, *Int. J. Res. Pharma. Biomed. Sci*., 3(4), 1614-1620(2012c).

Kumaresan, M., Palanisamy, P.N. and Kumar, P.E, Application of eco-friendly natural dyes on Cotton obtained from the stem of *Achras sapota* using combination of mordants, *Nat. Environ. Poll. Technol.*, 9(3),547-552(2010).

Samanta, A. K., Agarwal Priti and Datta Siddhartha, Dyeing of jute and cotton fabrics using jack fruit extract: part – I: Effects of mordanting and dyeing process variables on colour yield and colour fastness properties, IJFTR, 32(4), 466-476, (2007).

Sandeep Bains, Singh, O. P., Gangan Preet Goraya and Manpreet Kang, Dyeing of cotton with Goldendrop (*Onosma Echioides*) dye, *J. Textile Assoc.*, 183-186(2003).

Sandeep Bains, Sumeet Kang and Koshal Preet Kaur, Dyeing of wool with Peach (*Prunus persica*) dye using combination of mordants, *J. Textile Assoc*., 127-131(2005).

Thomas Bechtold, Mussak, R., Mahamud - Ali, A., Ganglberger, E. and Geissler, S., Extraction of natural dyes for textile dyeing from coloured plant wastes released from food and beverage industry, *J. Sci. Food Agric*., 86(2), 233-242(2006). doi: 10.1002/jsfa.2360